New developments in HarmonEPS and GLAMEPS, and future plans

Inger-Lise Frogner

and the HIRLAM EPS and predictability team, and
RMI for GLAMEPS

Rome, 2016

Topics

- GLAMEPS towards version 3
- Status of calibration work
- HarmonEPS towards operationalization
- Results from two experiments with HarmonEPS
  - Multi physics
  - Surface perturbations
- Plans for further developments of HarmonEPS

GLAMEPS (version 2, since October 2013)

Operational since 2011

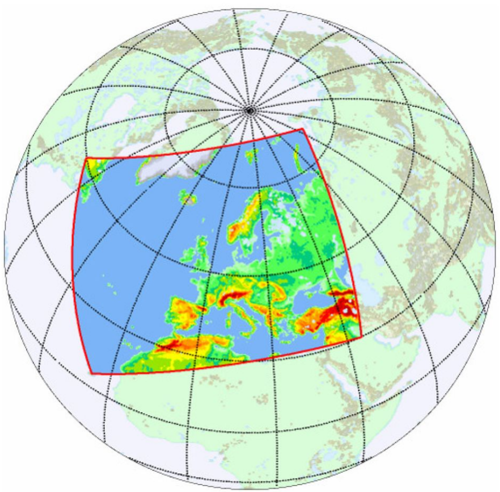
Multi-model, pan-European EPS

48 + 4 ensemble members; lagged
4 sub-ensembles:
- Two HIRLAM ensembles with 3D-Var for controls
- Two Alaro ensembles (downscaling) with SURFEX or ISBA for surface

Nested in IFS ENS

- Forecast range: 54h
- Four times a day (00, 06, 12 and 18 UTC)
  All members their own surface assimilation cycles
- Stochastic physics in HIRLAM
- Perturbed surface observations in HIRLAM
- ~8 km resolution

Runs as Time-Critical Facility at ECMWF



GLAMEPS

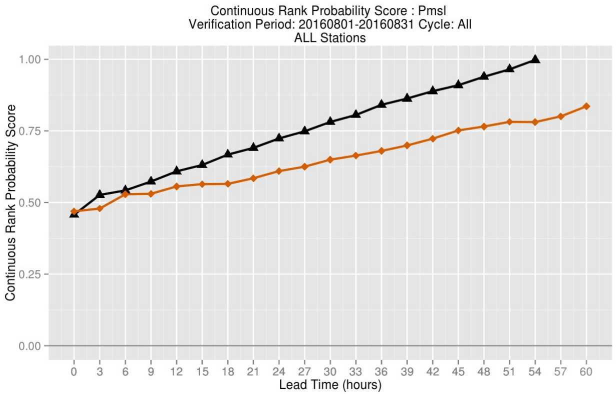
Kai Sattler, Alex Deckmyn, Xiaohua

GLAMEPS (version 2)

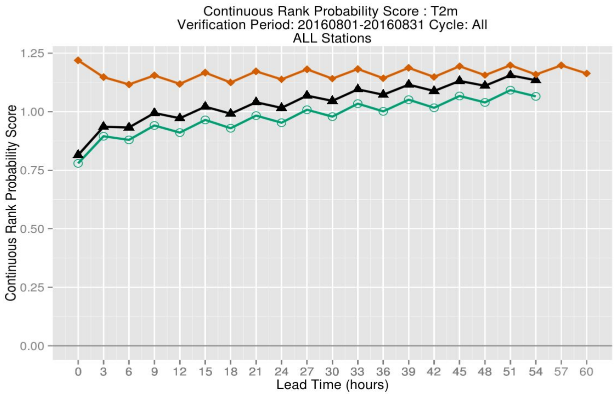
CRPS

ECMWF ENS
GLAMEPS raw
GLAMEPS cal.

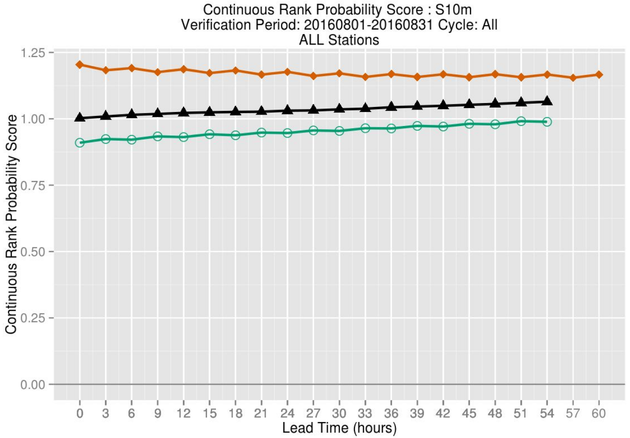
Pmsl



T2m



S10m



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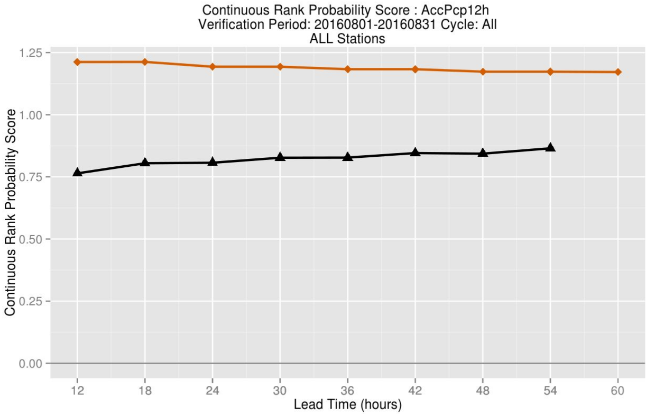
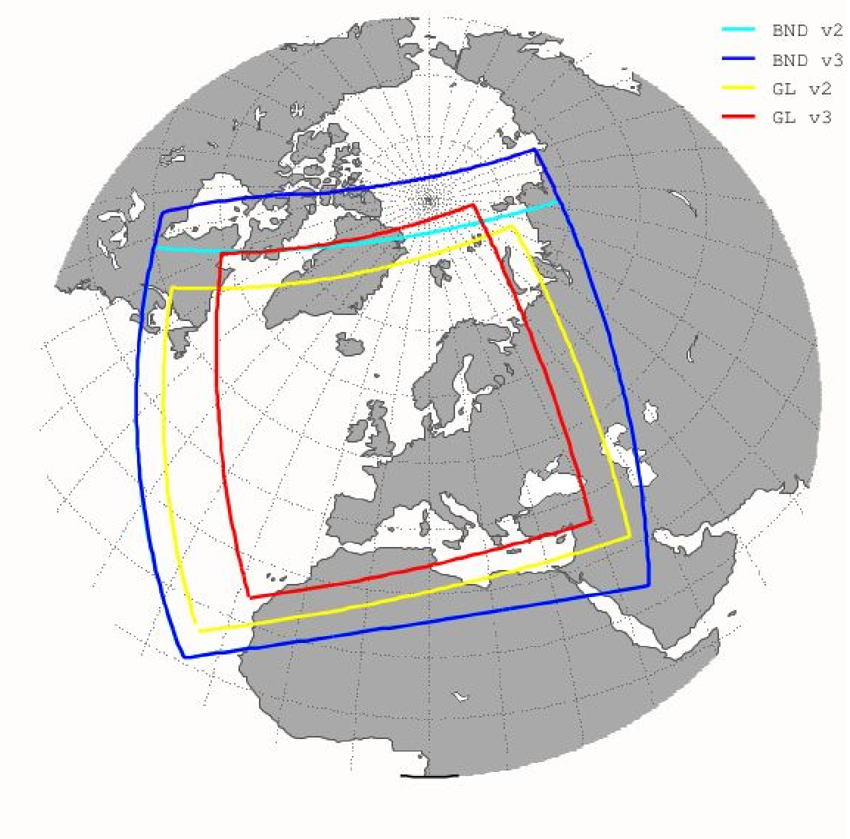


GLAMEPS (version 3, runs in parallel)

- Hourly output
- Increased resolution - 0.05 deg. (Hirlam) / 6 km Alaro
- Reduced area
- 36 members (4+1)
- Inflation of the initial perturbations coming from IFS ENS
- Include CAPE SVs in Hirlam
- ALARO upgraded from cy37 to cy38
- Parallel run since end July, aim to replace v2 by end of the year



Kai Sattler, Alex Deckmyn, Xiaohua

Calibrating GLAMEPS

Aim: Make well-calibrated forecasts at all model grid points based on (recent) historical data of

- synop measurements
- forecasts
- orographic and (model) climate information

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

Operational system:

T2m

Gaussian distribution with parameters:

- **mean**: ensemble mean + model elevation
- log(**standard deviation**): log(ensemble standard deviation) + log(model elevation})

S10m

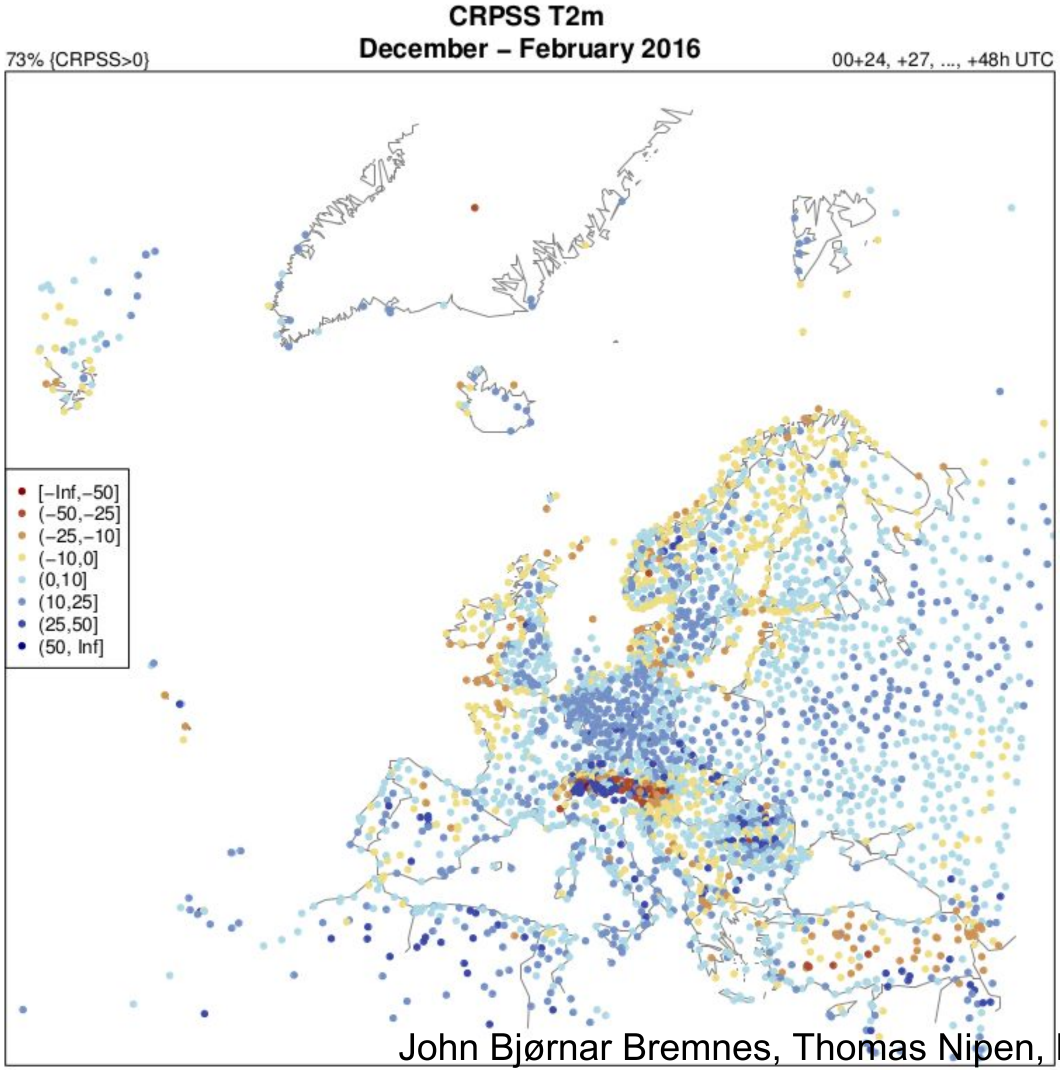
Box-Cox t-distribution with parameters

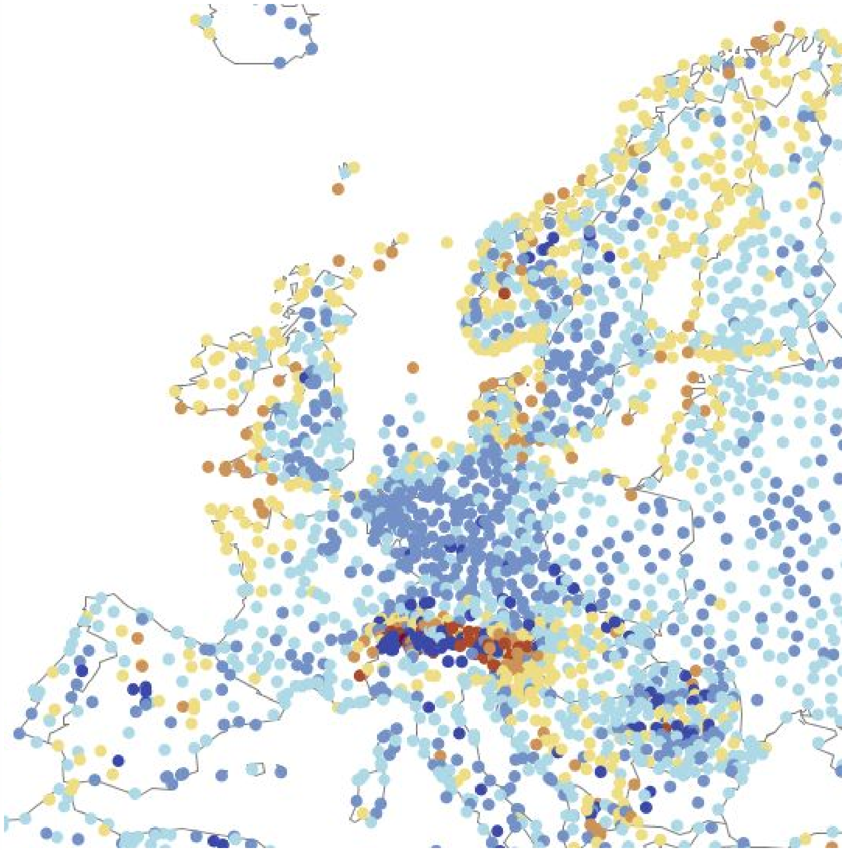
- **mean**: ensemble mean + model elevation
- log(**sigma**): log(ensemble standard deviation) + log(max{1,model elevation})
- **nu**: ensemble mean
- log(**tau**): constant

Training

- separate models for each forecast hour and lead time
- models updated every Thursday at approx. 05 UTC
- estimation time about 2 hours (T2m) and 5.5 hours (S10m)
- training period of 42 days (max. 20000 cases)
- no lagging

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits





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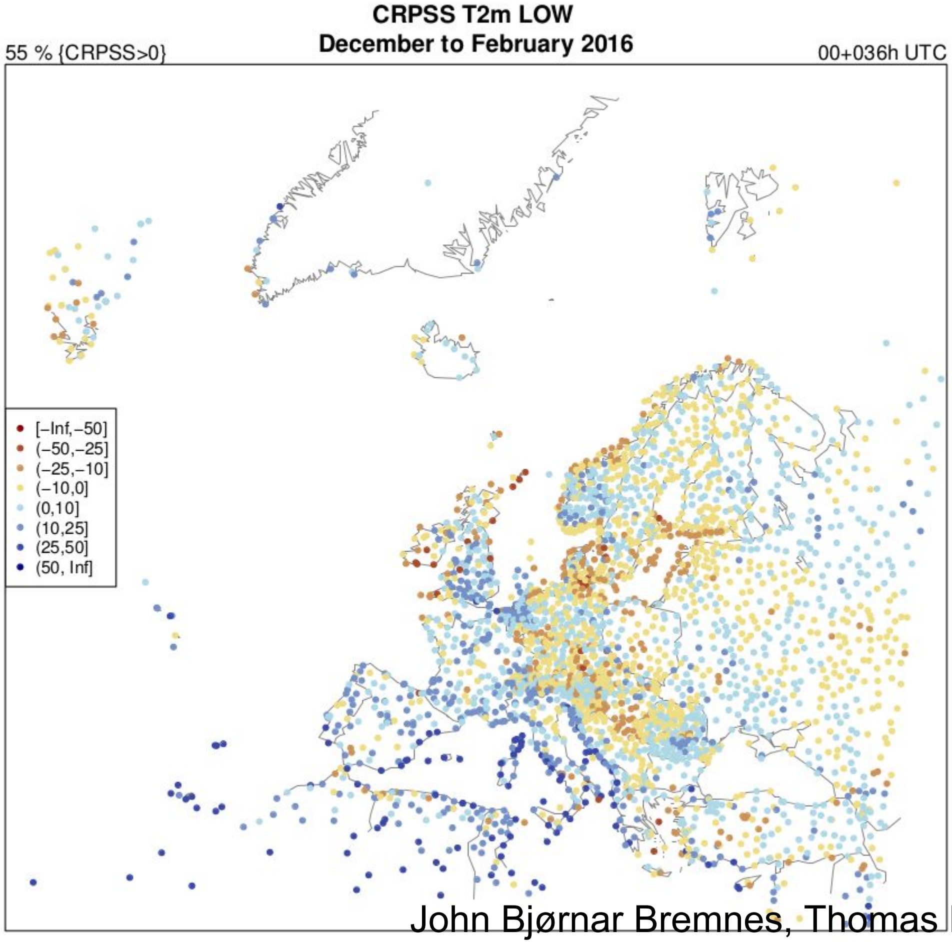
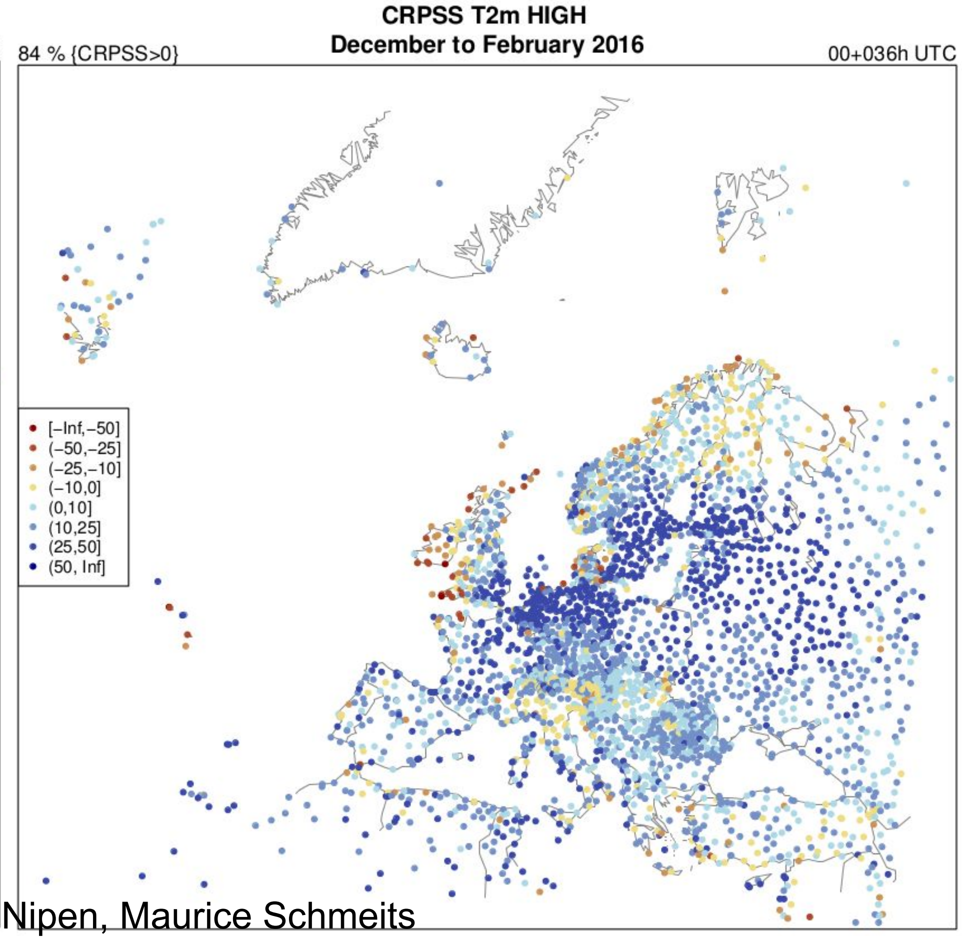
CRPSS when ensemble mean is ...





John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

Current work

- better modeling of spatial variations:
    a. Use flexible regression methods to predict spatial bias using training sample errors, orography and climate information
    b. use output from a) as input to the "probabilistic" regression model
- precipitation calibration
- Testing new methods
- Apply also to HarmonEPS

HarmonEPS

Experimental – first operational version in 2016

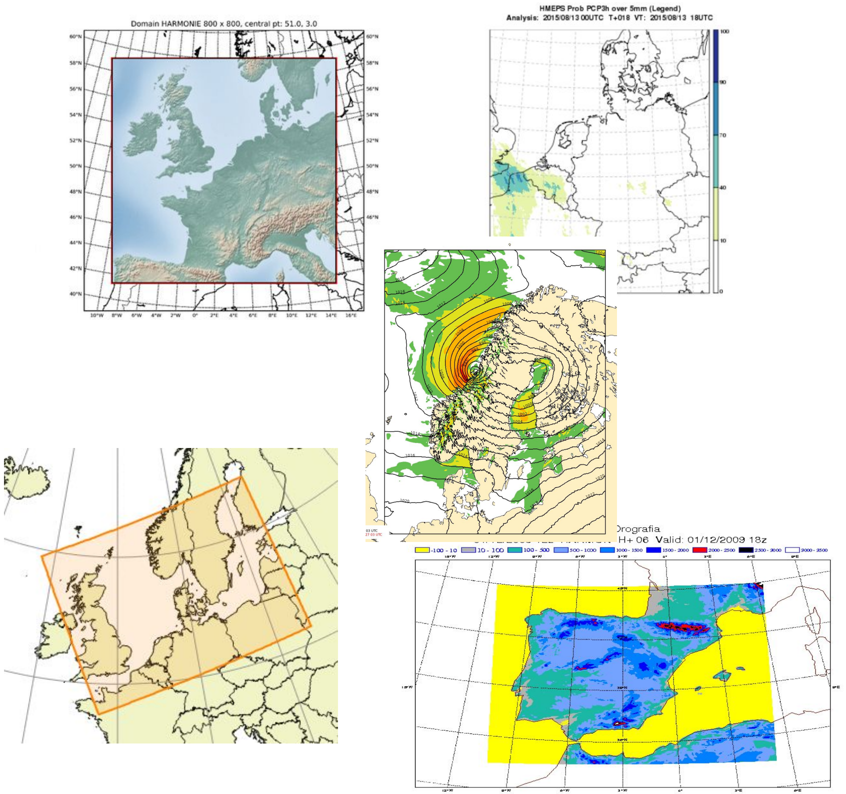
For European areas

- Configurations vary, but typically:
- ~10 members
- Arome (and Alaro)
- 2.5 km
- 3D-Var
- SURFEX
- ~+48 h

    All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.



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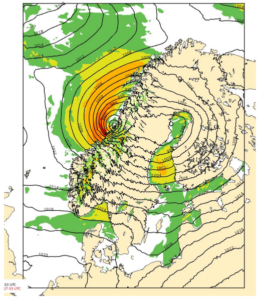
MEPS by MetCoOp (Sweden and Norway): see poster by Ulf Andrae

Operational 1. November 2016



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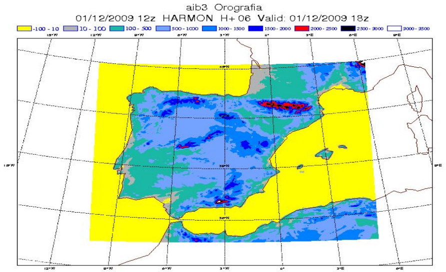
ɣSREPS from AEMET, Spain
Test runs since April 2016
Operational Q1 2017



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KNMI, Netherlands:
Start end of 2016

HarmonEPS

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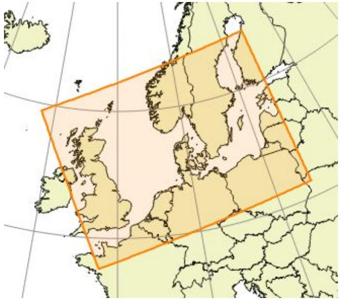
COMEPS by DMI, Denmark



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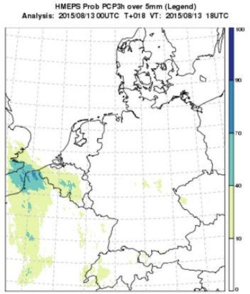


HMEPS: running in test mode, RMI, Belgium

Multi-physics with different parameterizations in HarmonEPS (Arome)

Experiment period: 20150720-20150810

Physic settings for each member

Mbr000: Arome ref.

Mbr001: $HARATU = TRUE$. Turbulence scheme based on the scheme in the RACMO model. (new mixing length, new stability functions)

Mbr002: $LOCND2 = FALSE$. Switch off microhysics option for separate ice-phase representation (Ivarsson, 2010).

Mbr003: $EDMF(CMF\_CLOUD = DIRE) + HTURBLEN = DEAR$. "Direct" cloud scheme coupled to the mass-flux in EDMF (instead of the "statistical" cloud scheme), and alternative mixing length in the CBR scheme (Deardorff (1977).

Mbr004: $EDKF(CMF\_UPDRAFT =' RAHA')$. Eddy diffusion mass-flux scheme with (Rio et al. 2008 and 2010) mass-flux formulation. ("Direct" cloud scheme)

Mbr005: $EDKF$. Eddy diffusion mass-flux scheme with (Kain-Fritsch) mass-flux formulation. ("Direct" cloud scheme)

Mbr006: $ACRANEB2$. ACRANEB2 radiation scheme in AROME.

Mbr007: $LGRSN = TRUE + LLCRIT = TRUE$. Convert graupel to snow more efficently in microphysics scheme, and more efficient precipitation from shallow convective cumulus in cold conditions.

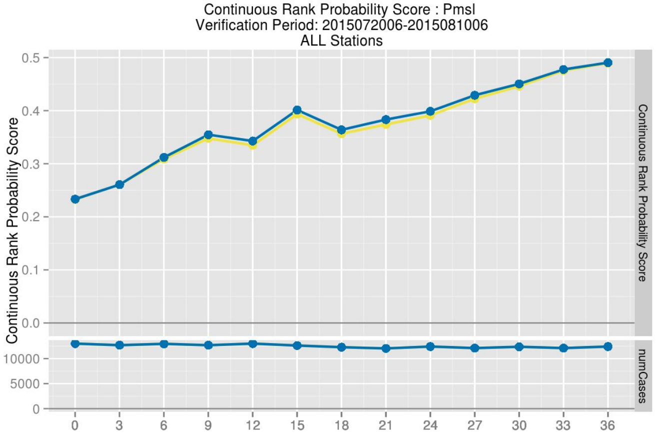
Mbr008: $LOCND2 = FALSE + HARATU = TRUE$.

Mbr009: $ACRANEB2 + EDKF$.

Mbr010: $'RLWINHF' =' 0.7.'$. Inhomogeneity factor for cloud-representation in a grid-box in radiation scheme switch to 0.7.

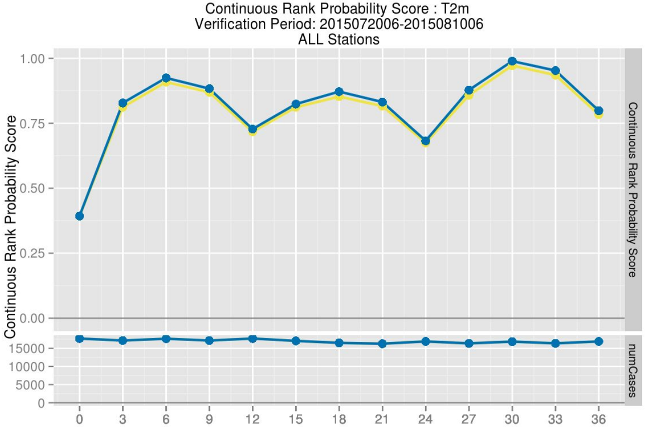
Bjorn Stensen, Lisa Bengtsson, Ulf Andrae

CRPS



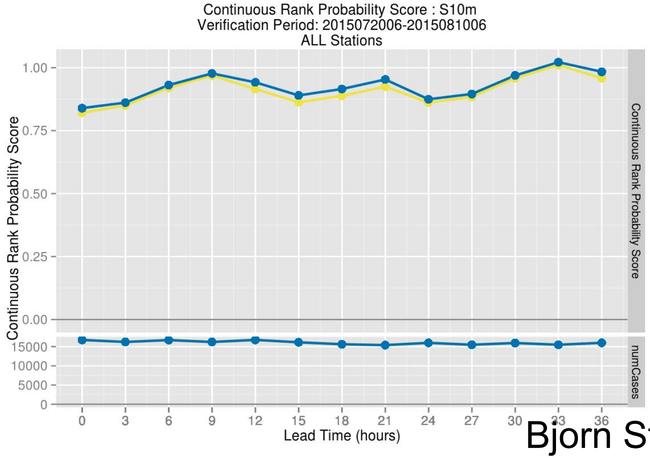
Pmsl

T2m



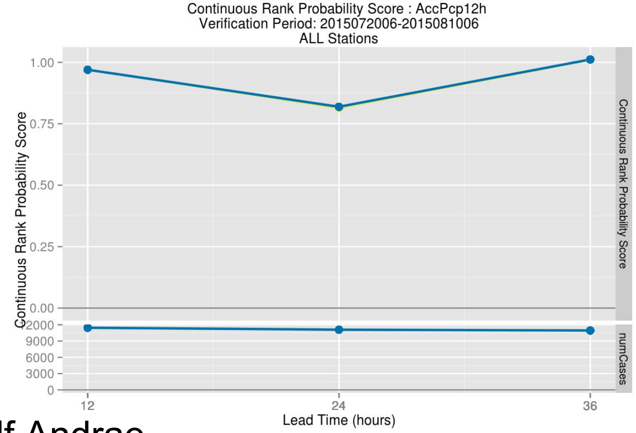
REF

Multi-physics



S10m

12hPcp



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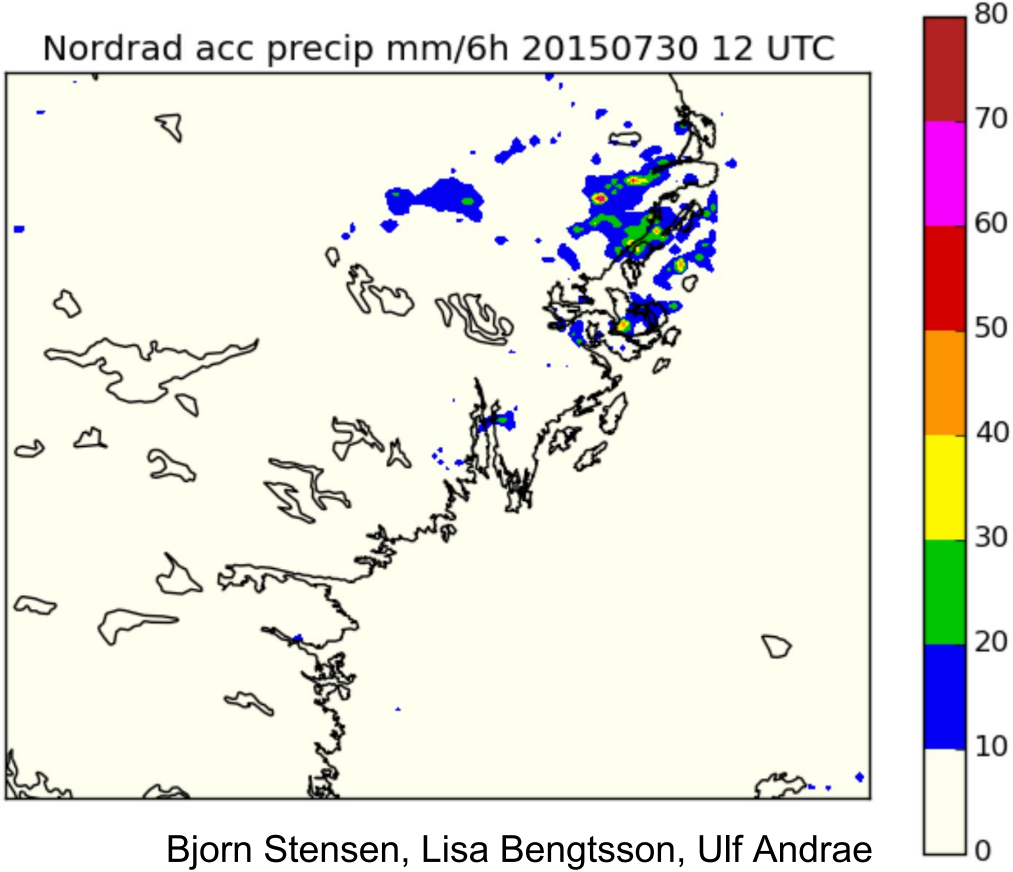
Case of heavy precipitation on the east coast of Sweden



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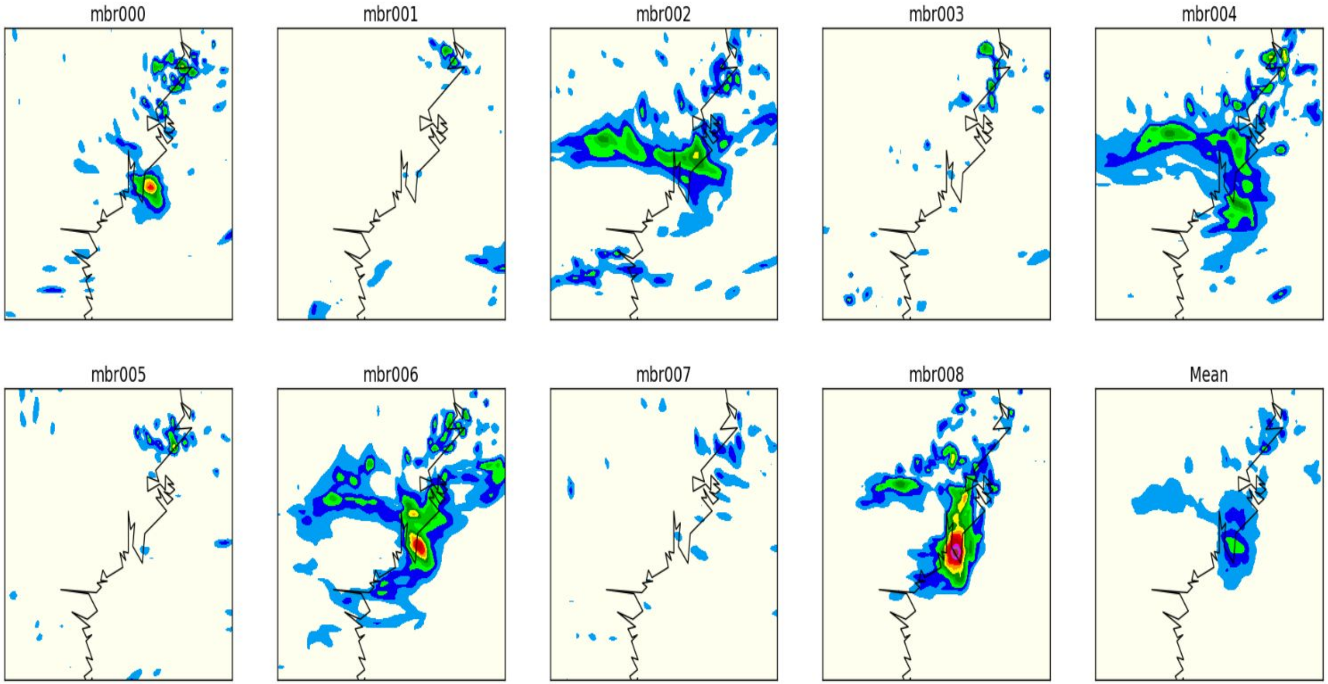
Case of heavy precipitation on the east coast of Sweden - Multi Physics



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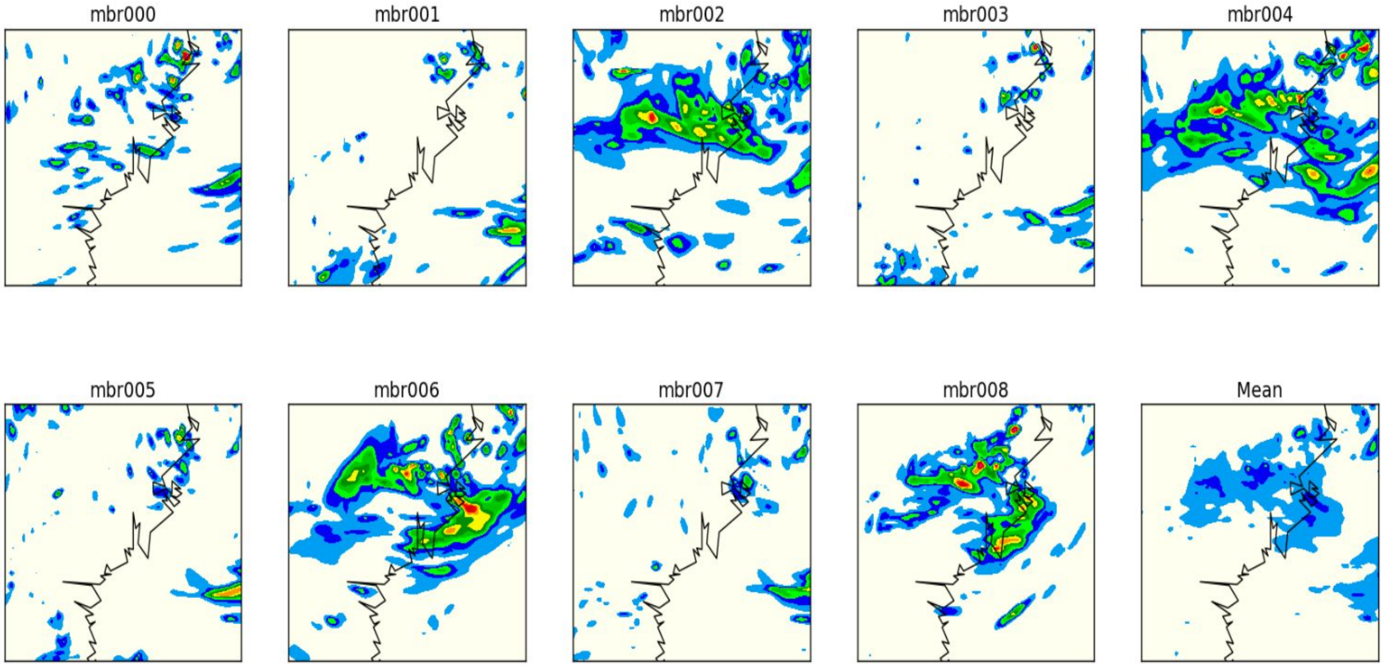
Case of heavy precipitation on the east coast of Sweden - Reference experiment



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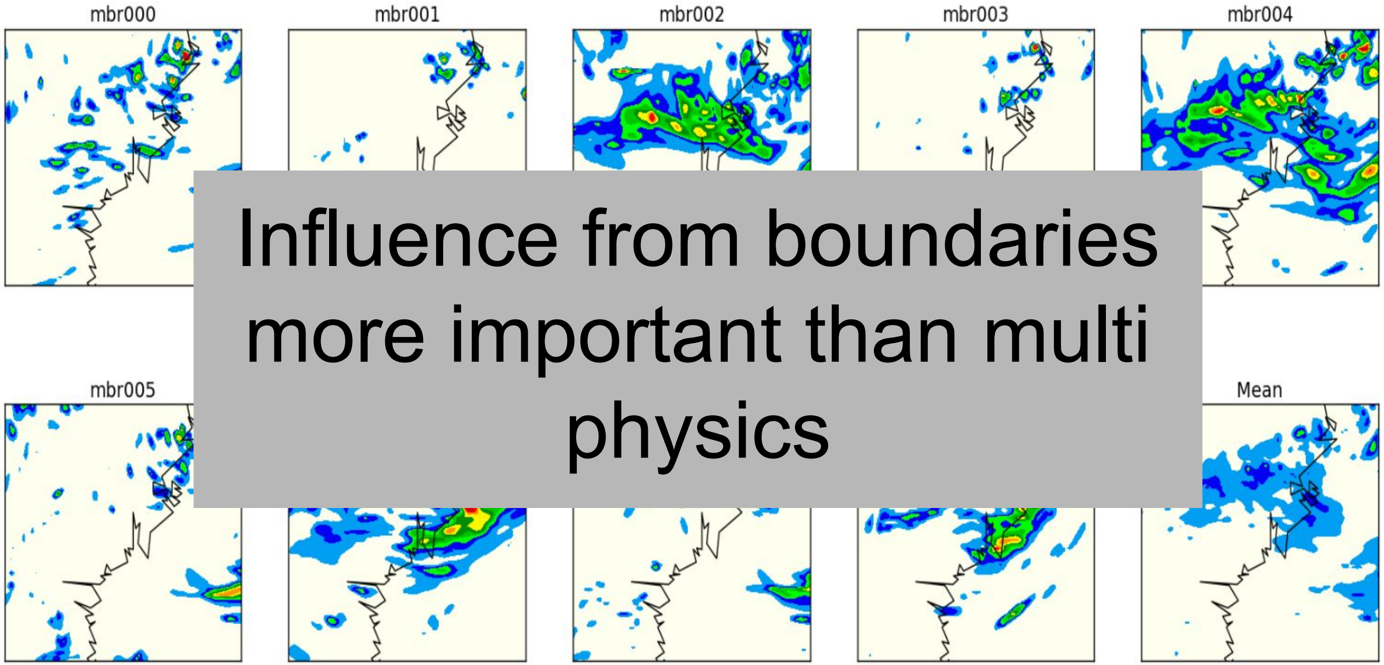


Influence from boundaries more important than multi physics

Bjorn Stensen, Lisa Bengtsson, Ulf Andrae

Surface perturbations in HarmonEPS (Arome)

Code from Meteo France:

Perturbing parameters like SST, soil temperature and humidity, albedo, LAI, ...

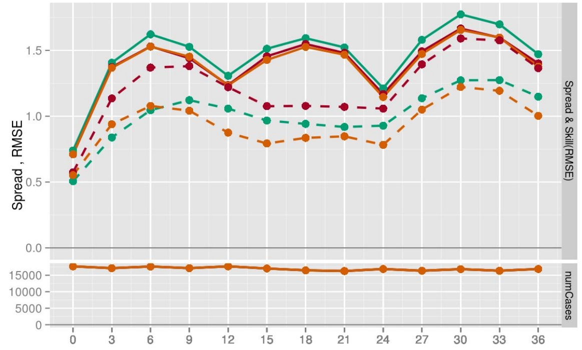
Experiment periods: 20150720-20150810
20151230-20160119

HarmonEPS

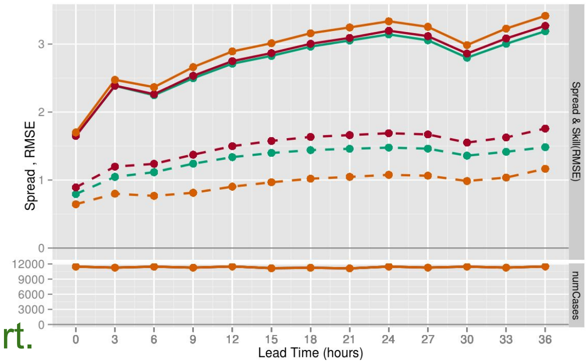
T2m

Surface perturbations

Summer



Winter

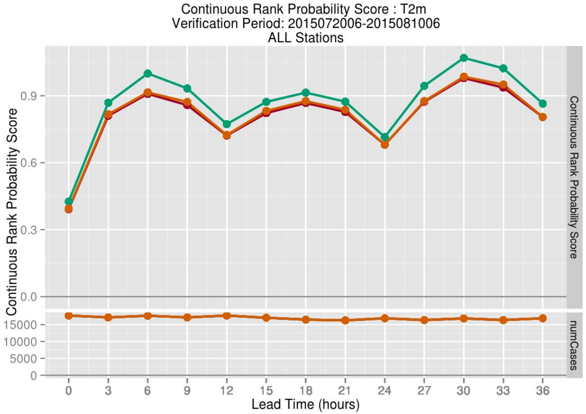


Spread-Skill

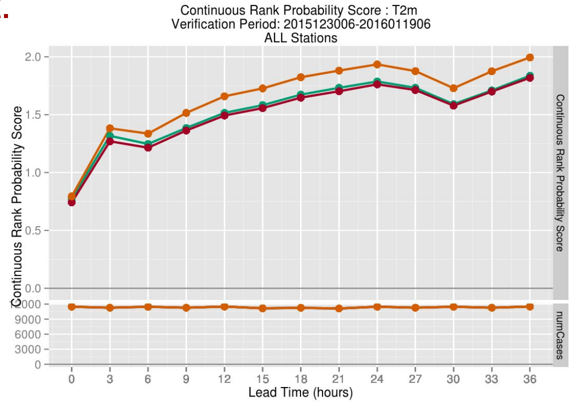
__ REF

__ Only surface pert.

__ REF + surf. pert.



CRPS



Andrew Singleton, Bjorn Stensen and Ole Vignes

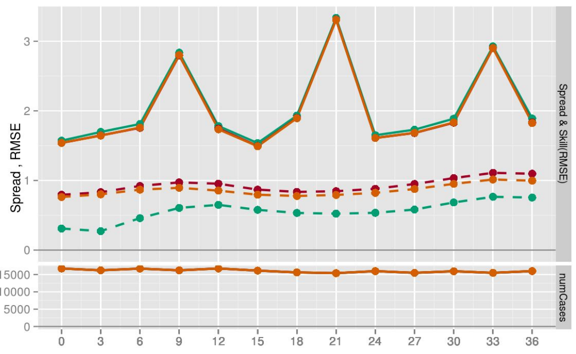
HarmonEPS

S10m

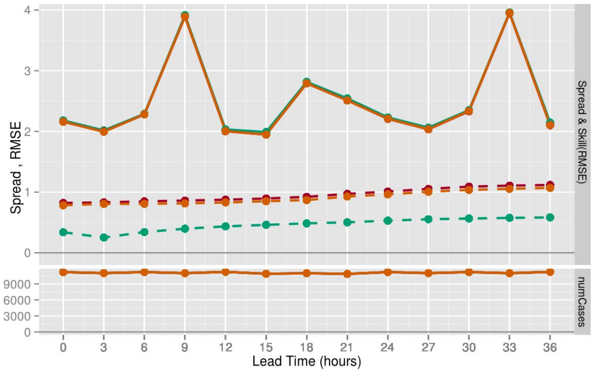
Surface perturbations

Summer

Winter



Spread-Skill



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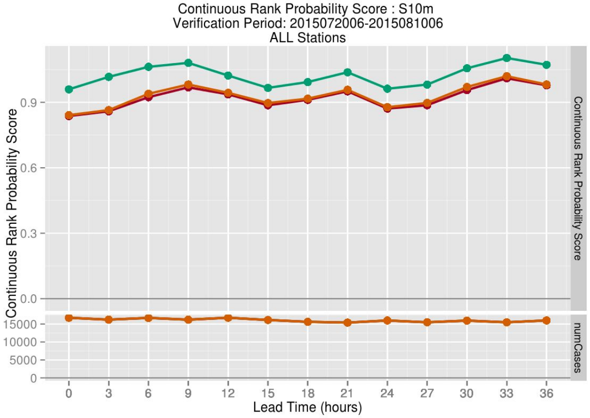

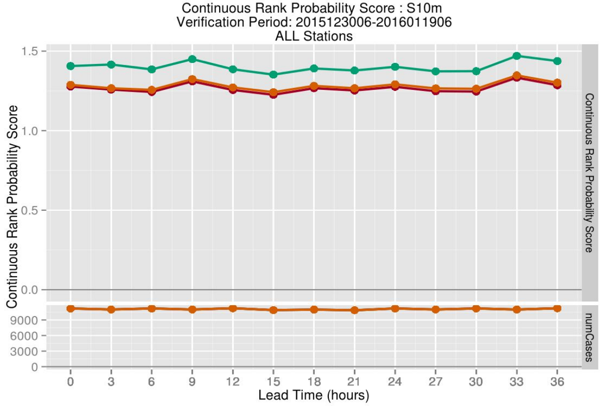

CRPS

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HarmonEPS

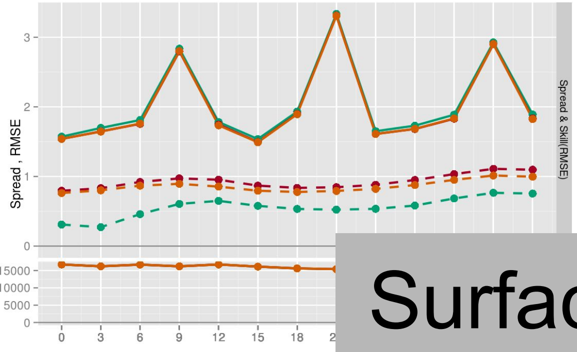
S10m

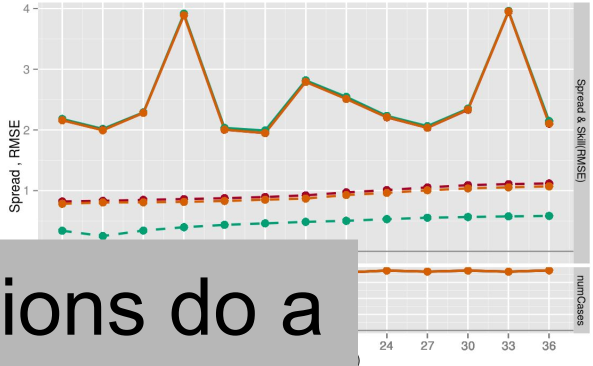
Surface perturbations

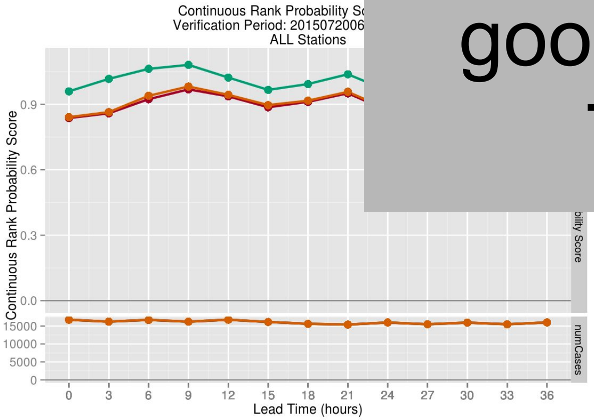
Summer

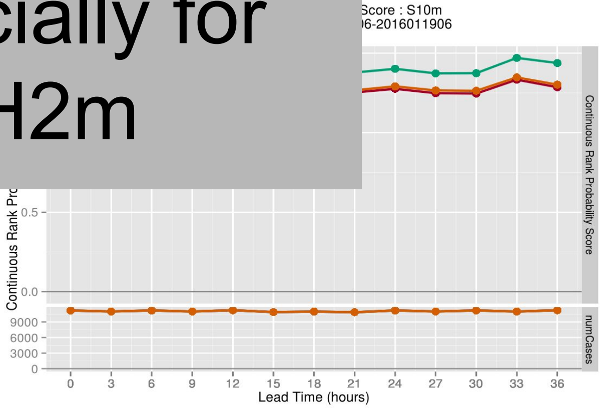
Winter

Spread-Skill







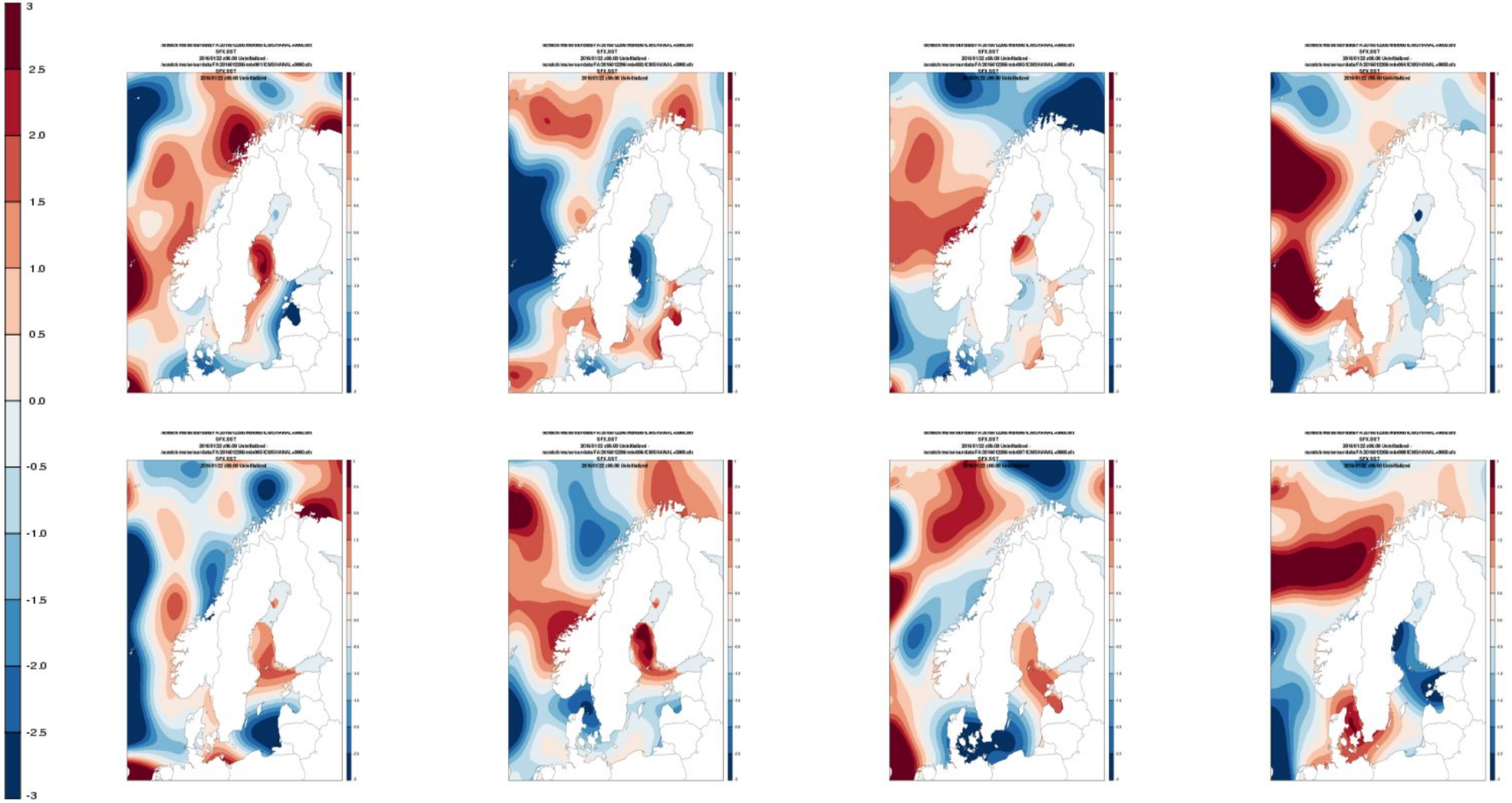


Surface perturbations do a good job, especially for T2m and RH2m

CRPS

Andrew Singleton, Bjorn Stensen and Ole Vignes

SST: mbr000-mbrXXX



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X001LAI
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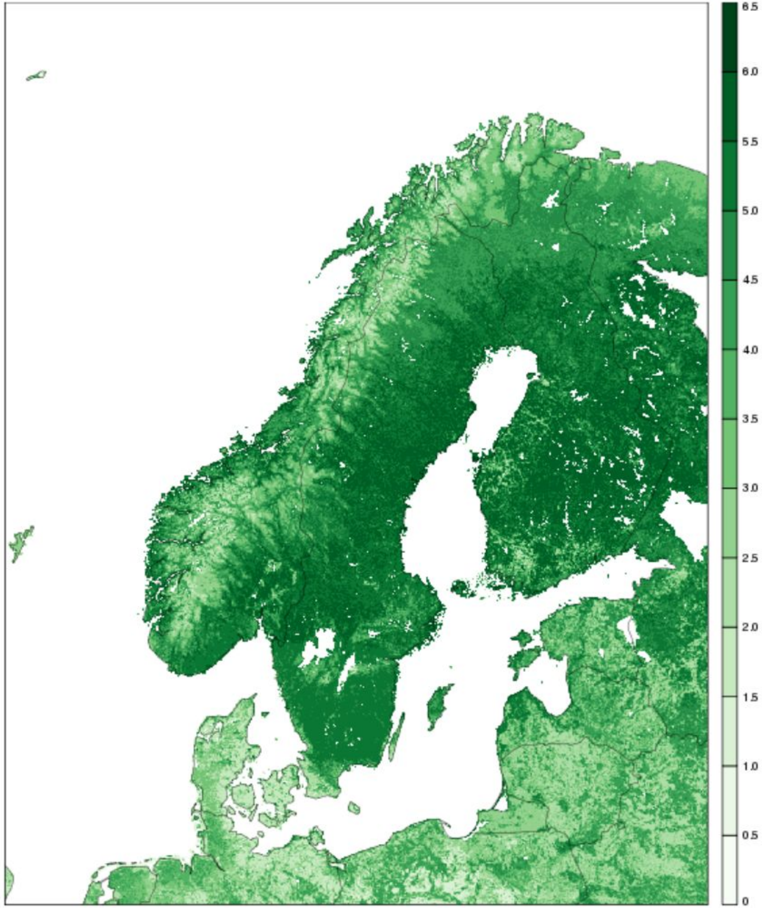

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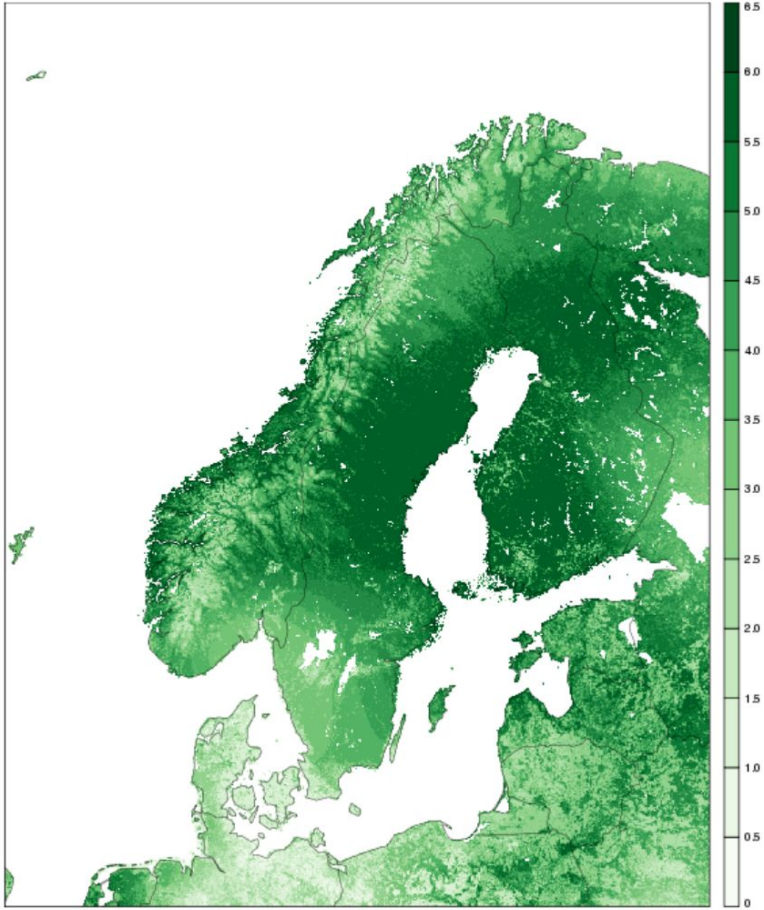

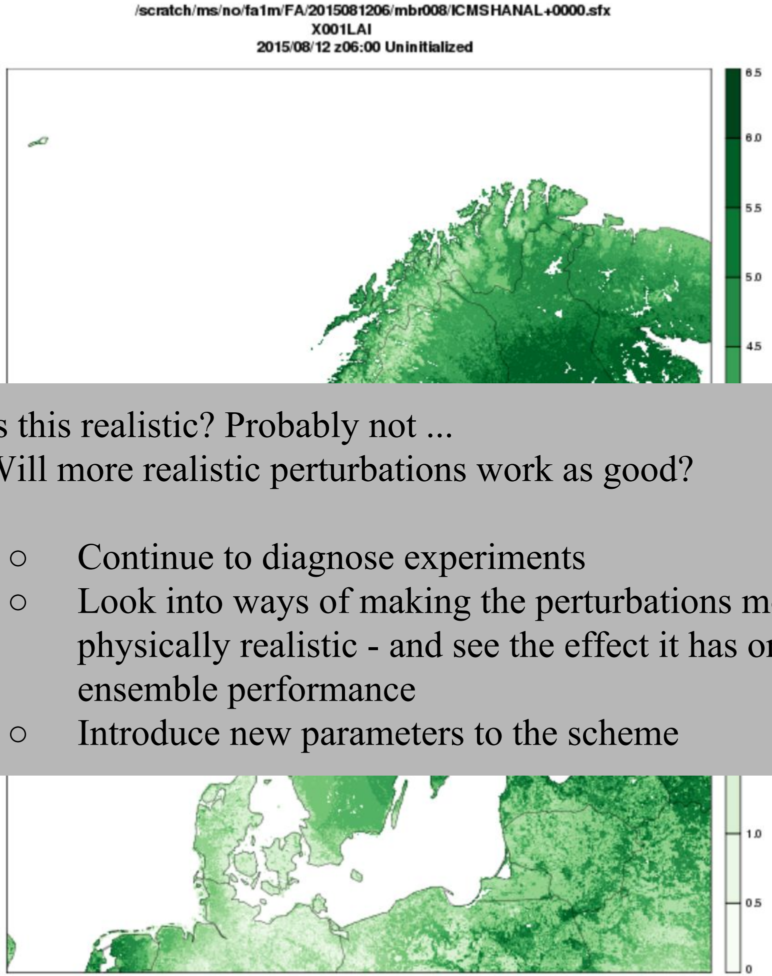

Is this realistic? Probably not ...
Will more realistic perturbations work as good?

- Continue to diagnose experiments
- Look into ways of making the perturbations more physically realistic - and see the effect it has on the ensemble performance
- Introduce new parameters to the scheme

Plans for further development of HarmonEPS

HarmonEPS and representation of

Initial state uncertainty

- Default is to use perturbations from IFS ENS/High. Res (SLAF)
- Continue to test EDA with 3D-Var
- LETKF under development
- Continue the study of creating equally likely initial conditions/ensemble members

Towards consistent design of DA and ensemble prediction - > 4DEnVar

HarmonEPS and representation of

Model error

- Multi-physics with different parameterizations in Arome
- SPPT
- Cellular Automata (CA) (Lisa Bengtsson) *Quart. J. Roy. Meteor. Soc.* doi: 10.1002/qj.2720
- **Stochastic perturbations in parameterizations / processes**
- Humidity perturbations and MSG cloud mask

HarmonEPS and representation of

Surface uncertainty

- **Continue to study, refine and develop surface perturbation code**

- Perturb surface physics: study perturbations in momentum, heat and moisture flux parameterizations

HarmonEPS and representation of LBC uncertainty

Experiments with different flavours of using IFS ENS and SLAF

Thank you